This Work Plan has been prepared for the pilot demonstration for the injection of in-situ chemical oxidation (ISCO) compounds at the Ashland Lakefront site as part of USEPA's SITE demonstration program. The Plan has been developed to meet the intent of a WDNR injection permit application. It is also intended as a supplement to the SITE demonstration plans being developed by USEPA's contractor for the program (Tetra Tech). This Work Plan includes background information, a detailed scope of services, and a proposed schedule.

1.0 BACKGROUND

The Ashland/NSP Lakefront Site was selected for a demonstration project by the USEPA's Site Innovative Technology Evaluation (SITE) program in August 2005. Subsequently, NSPW began discussions with DCI Environmental, Inc. (DCI) and DeepEarth Technologies, Inc (DTI) regarding the use of in-situ chemical oxidation techniques on contaminants identified in the Copper Falls and Filled Ravine aquifers for use in the demonstration project. DCI and DTI were then selected as NSPW's vendor for this demonstration project. NSPW submitted DCI/DTI's proposal to USEPA for the application of its *Cool-Ox*™ Technology for review in June 2006. USEPA then approved the proposal in July 2006.

It was determined that the pilot demonstration should be designed to investigate three basic concerns. These included locating an injection zone such that: 1) the effects on the artesian Copper Falls Aquifer could be assessed; 2) the chemical and biological activity of the technology could be measured, and 3) the mitigation potential of the Technology on the free product located in the Copper Falls Aquifer could be assessed.

The pilot demonstration will be limited to areas at the Upper Bluff near the former MGP. These include the free product plume in the Copper Falls Aquifer and portions of the Filled Ravine Aquifer. This pilot demonstration will be divided into two distinct treatment areas. The first area is near the MW-15 well nest, located in the alley south of the NSPW service center building. This area is a source area adjacent to former gas holders at the upgradient edge of the Filled Ravine, and a point where groundwater has a downward vertical flow gradient. The second injection area is located near the MW-13 monitoring well nest on the south side of St. Claire Street near the existing groundwater remediation treatment building. It is located about 150 feet northwest and downgradient of the MW-15 nest. This area was selected to provide information regarding the upward vertical gradient (artesian) flow conditions in the Copper Falls Aquifer. It was also selected to evaluate the effect of the reagent on the free product plume, as well as monitor any changes in the recovery rates of existing extraction wells located in this same area.

DTI owns the *Cool-Ox*™ In-Situ Chemical Oxidation Technology, which is an in-situ remediation technology that combines controlled chemical oxidation with accelerated biodegradation subsequent to the oxidation phase. However, unlike the Fenton or Fenton-like processes that use liquid hydrogen peroxide, the *Cool-Ox*™ Process generates its own hydrogen peroxide from solid peroxygens that are injected into the soil or groundwater in an aqueous suspension. Once in place, the peroxygens react with water to produce hydrogen peroxide. Because the *Cool-Ox*™ Process is not a Fenton-like process, it does not require the injection of iron salts or other metal catalysts to oxidize the contaminants, it does not generate heat, and

remains in the aquifer for longer periods of time due to the relative insolubility of solid peroxygen. Of the processes under consideration, the *Cool-Ox*™ Process was selected because of its ease of application, the controllability of the reaction, safety and its demonstrated ability to treat VOCs (BTEX) and SVOCs (PAHs).

Tetra Tech, selected as the contractor to USEPA, will prepare a quality assurance protocol (QAPP) and health and safety plan (HASP) specific to the pilot demonstration prior to the start of site activities. Tetra Tech will also oversee all field activities, perform a complete data analysis, and prepare a final technical evaluation of the technology under the guidance of the USEPA SITE program.

This plan includes details on monitoring points, injection points, injection quantities and methods. Treatment areas, monitoring and injection point locations area shown on Figure 1. The injection intervals are shown in cross section on Figure 2.

2.0 SCOPE OF SERVICES

NSPW will complete the following tasks.

Task 1 – Installation of Additional Monitoring Points

Prior to the initiation of the pilot demonstration, additional monitoring points will be installed. These include two points at the MW-15 nest and three at the MW-13 nest (one of these points at the MW-13 nest will include a replacement for MW-13B, which is dysfunctional; this existing well will be properly abandoned at the completion of the well installation described in this task). The two points at MW-15 will include a water table well (MW-27) installed with the screen bottom at elevation 625 msl (15-foot depth), and a piezometer (MW-15C) installed with the screen bottom at elevation 605 ft. msl (35-foot depth). The wells will be installed within a 10-foot radius of the existing well nest as access permits in the alley behind the NSPW service center. The water table well will be installed with a 10-foot long screen; the piezometer with a 5-foot long screen.

The additional monitoring wells at the MW-13 nest will be installed as piezometers with 5-foot long screens. They will be installed within a 30-ft radius of the limits of the existing well nest within the terrace and the area of the treatment building on the south side of St. Claire Street as access permits. The wells will be installed with the screen bottoms at elevations 560, 575 and 590 msl (75, 60 and 45 foot depths, respectively). The wells will be labeled MW-13BR, MW-13E, and MW-13F.

Each of the wells will be constructed as conventional 2-inch diameter PVC wells with 0.010-inch slot size openings in accordance with ch. NR 141, Wisconsin Administrative Code (WAC) using mud-rotary drilling techniques. Each boring will be advanced to the target depth and the well installed (soil sampling will not be performed because the lithology is well defined). Each well will be properly developed following installation.

The locations of the proposed and existing monitoring points are shown on Figure 1. This is provided for planning purposes only since access to many of the proposed locations may be restricted.

Task 2 – Baseline Monitoring Program

Groundwater samples will be collected to establish baseline concentrations for wells in the vicinity of the *Cool-Ox*™ injection. These include samples from existing wells MW-15, MW-15A, MW-15B, MW-16[1], MW-13A, extraction wells EW-1, EW-2 and EW-3, and proposed wells MW-27, MW-15C, MW-13BR, MW-13E and MW-13F. The baseline sample results will be used to assess the effects of *Cool-Ox*™ on the free product plume, as well as VOC and PAH concentrations and biological indicator parameters. Baseline groundwater samples will be collected 10 days prior to the start of the injection process.

USEPA recommends that the laboratory analyses for the baseline samples include VOCs, PAHs, carbon isotope analysis, heterotrophic and plate count measurements, pH, dissolved oxygen, and temperature.

Task 2 – Cool-Ox*™ *Injection

Following authorization, NSPW will mobilize to the site and set up the drilling and injection equipment. Mobilization and set up activities will include: locating the injection zones, staging sanitary facilities, setting up decontamination zones and equipment (in accordance with the HASP that will be developed for the SITE demo), clearing utilities, erecting barrier fencing and any activities that shall be deemed necessary once work crews have arrived and surveyed the area. A site safety meeting will be conducted prior to initiating any work.

All injection points will be installed using direct-push techniques (DPT) using a Geoprobe track-mounted rig. Each point will be driven to the specified maximum depth and the injection process initiated. Injection of the *Cool-Ox*™ oxidant will begin at the maximum depth and continue upward at specific intervals toward the surface to the specified start depth. Once the oxidizing reagent has been injected, grout will be injected into the boring from the uppermost injection interval back up to the surface. The grout will seal off and maintain the integrity of the Miller Creek Formation (the confining unit separating the Ravine fill and Copper Falls aquifers) to prevent any potential future cross-contamination. The remaining injection points will then be installed across the treatment zone to complete the grid.

The following table includes information on injection point depths, grid spacing, and oxidant volume at each well nest location. It has been reproduced from the original June 2006 DTI/DCI proposal:

[1] MW-16 is located approximately 40 feet south and upgradient from the MW-15 nest. It will provide an upgradient background sample collection point.

	MW-13 Nest	***MW-15 Nest***	***Totals***
Contaminants:	MGP (VOCs/SVOCs)	MGP (VOCs/SVOCs)	
Media Treated:	Soil & GW	Soil & GW	
GW Depth (feet):	5 feet	5 feet	
Area (sf):	2,400	1,500	3,900
Vertical Interval (bgs)[2]:	5 to 80	5 to 40	
Cubic Yards:	6,667	1,945	8,612
IP Spacing (feet)[3]:	9.5	8	
No. of IPs[2]:	27	23	50
Cool-Ox™ gal/cy:	5	5	
Estimated Total Gal:	33,633	9,725	43,358
Estimated Work Days[4]:	29	15	44

Upon completion of the injection at each location, the borehole will be observed for the evolution of foam (see Exhibit III of DCI/DTI's proposal), which confirms the presence of organic contaminants in that borehole. Each injection point will be observed to determine if a source is present that could contribute to the contaminant presence in the groundwater.

The *Cool-Ox*™ reagent will be mixed on-site and injected using the *Deep Shot Rig*™ in combination with DPT equipment (see Exhibit V of DCI/DTI's proposal). A Geoprobe track-mounted DPT rig is proposed for this work. The *Deep Shot Rig*™ is a completely self-contained machine. It is powered by a diesel engine that drives hydraulic pumps that power the leveling outriggers as well as the transfer and injection pump. The injection hose is of a wire- wound, high-pressure hydraulic type designed to withstand pressures of at least three times the by-pass pressure release valves of the injector pumps.

MW-15 Well Nest

The MW-15 injection area is located in the alley south of the NSPW service center building, which is a source area near former gas holders. This area was selected for treatment because of the proximity of the former gas holders, located immediately north of the MW-15 well nest. Based on groundwater elevations, confined aquifer conditions are present in the Copper Falls Aquifer just to the north of this location and beyond in most areas of the site (see Figure 2); however, they are not present in this area. Injection of *Cool-Ox*™ in this area will allow the downward flow gradients to carry the *Cool-Ox*™ reagent vertically downward and north (in the direction of horizontal flow) into the main area of the free product plume.

[2] The vertical injection interval is an average.

[3] Reflects the number of injection points without interference from obstructions. This number may change during the injection process to accommodate treatment of source areas discovered during the site work or to avoid structures in the injection zone. However, the total volume of reagent will be injected even if the injection pattern or numbers of injection points vary to meet site conditions.

[4] The time required for the overall injection work for both soil and groundwater is based upon one crew working an eight hour shift.

The MW-15 injection area measures 30 by 50 feet for a total of 1,500 square feet. Approximately 23 injection points will be drilled in this area on an eight-foot grid. Where subsurface utilities are present, the injection points may be moved slightly if necessary. This treatment area will allow groundwater data collection from two sources for comparative purposes; part from the existing and proposed monitoring wells at the MW-15 well nest (described above), and part from monitoring well MW-16 located upgradient and has not been impacted by the contaminant plume.

The vertical injection interval for this area will be from 5 to 40 feet below ground surface (bgs), a total of 35 feet. At each injection point, the downhole tools will be driven to the 40 foot maximum depth, and the injection of the *Cool-Ox*™ oxidant will commence. Seventy-five gallons of *Cool-Ox*™ oxidant will be injected at 40 feet bgs, and the tools will be pulled up to the next injection depth of 35 feet, where another 75 gallons of *Cool-Ox*™ will be injected. The injection process will continue in this manner at depths of 30 and 25 feet bgs, respectively. The 25 foot depth corresponds to the bottom of the Miller Creek Formation, which separates the Filled Ravine and Copper Falls aquifers. It should be noted that although the volume of reagent is designed over a uniform vertical interval (14.5 gallons per foot), the vertical distribution will be adjusted to place the preponderance of the volume just under and into the smeared or free product zone.

At the 25 foot depth, grout slurry will be tremied through the same injection tooling as the *Cool-Ox*™ reagents up to a depth of 15 feet. This 10-foot annular space seal will seal off the potential migration pathway created by the injection tooling and maintain the integrity of the Miller Creek Formation. At the 15-foot interval, injection of the *Cool-Ox*™ reagents will resume to treat contaminants in the primary source area (the Filled Ravine). The injection will be terminated at 5 feet bgs and all downhole tooling will be withdrawn. The remaining five feet will then be sealed with bentonite chips to prevent possible escape of contaminants to the surface or intrusion of possible surface contaminants into the borehole. Injection points located in paved areas will then be patched with appropriate materials at the conclusion of each boring.

Approximately 9,725 gallons of *Cool-Ox* ™ reagent will be injected through 23 injection points. Although the designed injection rate is about 3 gallons per minute, this may vary depending upon the circumstances encountered.

MW-13 Well Nest

The MW-13 injection area is located near the middle of the free product plume in the Copper Falls Aquifer and includes the monitoring wells in the MW-13 well nest as well as free-product recovery wells EW-1, 2, and 3.

This area was selected for treatment because it is located in the central portion of the free product plume, and currently has three of the four free-product recovery wells actively pumping from the Copper Falls Aquifer nearby (See Figure 1). In addition, the highest historical levels of free product in all site wells have been measured in monitoring well MW-13B, which is screened from 65-70 feet bgs (as previously indicated, MW-13B is dysfunctional and is proposed for

replacement as part of this program). Based on historic groundwater elevations, artesian flow conditions are present in this area (See Figure 2). Injecting oxidant in and below the free product plume in this area will utilize the artesian conditions to mobilize the *Cool-Ox*™ oxidant upward into the thickest part of the free product plume. This will maximize the contact of the oxidant with the free product mass to achieve the greatest possible level of remediation.

The MW-13 injection area measures 40 by 60 feet, a total of 2,400 square feet. Approximately 27 injection points will be drilled in this area on a 9.5-foot grid. Where subsurface utilities are present, the injection points may be moved slightly if necessary.

The vertical injection interval for this area will be from 30 to 80 feet below ground surface (bgs), a total of 50 feet. At each injection point, the downhole tools will be driven to the 80 foot maximum depth, and the injection of the *Cool-Ox*™ oxidant will commence. A total of 140 gallons of *Cool-Ox*™ oxidant will be injected at 80 feet bgs, and the tools will be pulled up to the next injection depth of 75 feet, where another 140 gallons of *Cool-Ox*™ will be injected. The injection process will continue in this manner every five feet, up to a depth of 30 feet. The 30 foot depth corresponds to the bottom of the Miller Creek Formation, which separates the Filled Ravine and Copper Falls aquifers. This injection interval will be restricted to the Copper Falls Aquifer only. The free product mass is confined to this zone because of the strong upward gradients measured at this well nest. The volume of reagent is designed over a uniform vertical interval (28 gallons per foot). The vertical distribution will be adjusted as needed to place the preponderance of the volume just under and into the free product zone.

At the 30 foot depth, grout slurry will be tremied through the same injection tooling as the *Cool-Ox*™ reagents up to the surface. This will plug the potential migration pathway created by the injection tooling and seal off and maintain the integrity between the upper Filled Ravine Aquifer and the lower Copper Falls Aquifer. This will also prevent possible escape of contaminants to the surface or intrusion of possible surface contaminants into the treatment interval. Injection points located in paved areas will be patched with appropriate materials at the conclusion of each boring

Approximately 33,633 gallons of *Cool-Ox* ™ reagent will be injected through 27 injection points. The designed injection rate is about 3 gallons per minute; this may vary depending upon the circumstances encountered and observations of activity in monitoring or extraction wells. The pilot demonstration in this area will help to develop information on the effect of the *Cool-Ox*™ oxidant on the free product mass located in the Copper Falls Aquifer.

Task 3 – Post-Injection Monitoring Program

After completion of the pilot demonstration, three rounds of groundwater samples will be collected to monitor conditions in the Copper Falls Aquifer due to the effects of the *Cool-Ox*™ oxidant. Groundwater samples will be collected 30, 60 and 90 days after the injection process is completed. It is anticipated that the post-injection monitoring at the MW-15 treatment area can commence after injection in this area is completed and while injection is taking place at the MW-

13 well nest. This will expedite laboratory analysis and subsequent data evaluation. The samples will be collected from the same 13 monitoring points described above in Task 2.

These sample results, when compared with the baseline samples collected before the *Cool-Ox*™ injection, will be used in the final data analysis to evaluate the efficiency and effectiveness of the Cool-*Ox*™ oxidant on the free product plume.

USEPA recommends that the laboratory analyses for the groundwater samples include VOCs, PAHs, carbon isotope analysis, heterotrophic and plate count measurements, pH, dissolved oxygen, and temperature.

Task 4 – Laboratory Analyses

Groundwater samples will be analyzed by USEPA's laboratory in Cincinnati, Ohio.

Task 5 – Data Analysis and Report Preparation

Tetra-Tech will perform the primary data analysis and final technological evaluation under direction of the USEPA SITE coordinators. Tetra-Tech will be responsible for the following documents:

1. Technological Evaluation Bulletin – brief two-page summary of activities, preliminary data assessment, and evaluation results.
2. Site Technology Capsule – brief 8-12 page technology-specific report within 120 days of completion of the pilot demonstration.
3. Innovative Technology Evaluation Report (ITER) – final data package with results of the technical evaluation, including the QAPP and validated data.

NSPW will provide assistance to Tetra Tech as needed for this task.

3.0 SCHEDULE

Tetra Tech will submit a QAPP and HASP specific to the pilot demonstration to USEPA prior to the start of site activities. After Tetra Tech receives approval from USEPA, the additional monitoring points will be installed as described in Task 1. These activities should be completed within one week. One week after well development, baseline data will be collected from the 13 proposed monitoring points. The injection program at the MW-15 well nest will be initiated 10 days after the baseline sampling is conducted, followed by the injection program at the MW-13 well nest.

NSPW will proceed with the pilot demonstration for *Cool-Ox*™ injection on the Upper Bluff following USEPA and WDNR approval on this Work Plan and the Tetra Tech QAPP and HASP. Assuming this Work Plan and Tetra Tech's plans are approved by September 1, 2006, installation of the additional monitoring points will be scheduled for mid-September. The following table is a preliminary schedule for program implementation:

Installation of additional monitoring points	September 18 - 22, 2006
Baseline groundwater sampling	October 2 – 6, 2006
Injection at MW-15 well nest (15 days)	October 16 – November 1, 2006[5]
Post-injection monitoring (MW-15)	December 4 – 7, 2006
	January 8 – 11, 2007
	February 5 – 8, 2007
Injection at MW-13 well nest (29 days)	November 2 – December 8, 2006[6]
Post-injection monitoring (MW-13)	January 8 – 11, 2007
	February 5 – 8, 2007
	March 5 – 8, 2007

This SITE demo is being performed concurrent with the FS activities for the Ashland Lakefront Site. The information from the demonstration will be incorporated in the final FS documents. USEPA's draft Statement of Work for the SITE demo indicates that Tetra Tech's Site Technology Capsule will be due 120 days after completion of the technology evaluation. To expedite this data reporting, it is recommended that this 120-day period commence with the completion of the injection program at the MW-13 well nest. Accordingly, the Capsule should be available on or about April 7, 2007. This will allow incorporation of the final monitoring event into the Capsule report.

[5] Assumes 6-day work weeks
[6] Assumes 4-day break (November 23-26) for Thanksgiving